

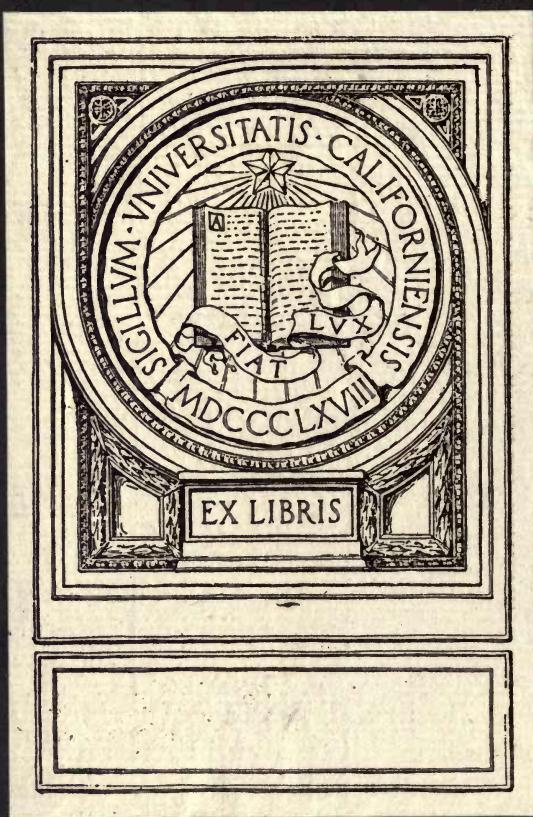
T E  
270  
A53

UC-NRLF



\$B 79 241

YC 69433



8

# American Society of Municipal Improvements, 1915

## SPECIFICATIONS FOR **BITUMINOUS PAVING**

ADOPTED OCTOBER 14, 1915

These specifications will be modified from time to time to keep them fully up to date. Suggestions as to modifications or additions are solicited and should be sent to the Secretary, or to Linn White, South Park Commission, Chicago, Ill., Chairman of the Sub-Committee on Specifications for Bituminous Paving, and—

**G E O R G E W. T I L L S O N**  
Boro Hall, Brooklyn, New York  
Chairman of General Committee on Standard Specifications

#### COPYRIGHTED, 1916

Any municipality which is represented in the membership of the Society by one or more city officials, will be given free permission to use these specifications or any part of them upon application to the Secretary

PUBLISHED BY THE SOCIETY  
**CHARLES CARROLL BROWN, Secretary**  
702 WULSIN BUILDING  
INDIANAPOLIS, INDIANA

TE270  
A53

## SPECIFICATIONS FOR BITUMINOUS CONCRETE PAVEMENT.

### *Sub-Grade.*

The contractor will be required to do all of the grading necessary to bring the surface to the proper sub-grade as determined by the lines and grades given by the engineer. If the material at sub-grade is of an unstable character and unfit for foundation, the contractor shall make such additional excavation as may be determined by the engineer and refilled with approved material. After all necessary grading has been done to bring this surface to sub-grade, the street shall be thoroly rolled with an approved road roller weighing not less than ten tons. If settlement occurs the depressions shall be filled and then re-rolled until the surface is solid, uniform and parallel with the grade and cross-section of the finished pavement. All filling shall be free from animal or vegetable matter and of a character approved by the engineer. In cases of spongy or yielding sub-grade some other means besides ordinary rolling and sprinkling must be employed to obtain satisfactory compaction of the sub-grade. In the case of loose, sandy soils, a small amount of cinders, gravel or fine crushed stone spread over the surface will often put it in a condition to be compacted under the roller. In the case of clay soils that puddle up and wave or creep under continued rolling, it is best to roll as dry as possible and to be sparing in the use of water when rolling the first layer of macadam. Cinders, gravel or stone screenings will often help in rolling such sub-grades.

### *Sub-Drainage.*

When the soil is of such a character that it retains an excessive amount of moisture, such as clay, subject to swelling or heaving under the action of frost, or sands similar to quicksand that do not afford a ready natural drainage, sub-drains should be provided.

These may be of two general kinds; first, tile drains of open porous material of vitrified tile laid with open joints; second, trenches filled with broken stone, gravel, cinders or other similar material.

In some cases it may be sufficient to construct a sub-drain on each side of the roadway at or near the lines of the gutters, but when the

soil is of a very wet nature it may be advisable to lay additional lines of drains which may be in or near the middle of the roadway. This system of drains may be varied by diagonal lines of drains running from near the crown of the roadway to the gutters.

In all cases the drains should have connections with the existing sewers, catch basins or inlets.

#### *New Macadam Foundation.*

If the pavement is to be laid on a new macadam foundation or base, the latter shall be built as follows:

The total thickness of the macadam base will vary according to character of soil, drainage, kind of stone available, etc. In general, the macadam base should be constructed of broken stone which is sound, hard and durable under traffic. The broken stone should be separated into different sizes by screening, the smaller sizes with the dust, being used to fill and bond together the larger sizes. The thickness of the base should be regulated by experience in constructing ordinary water-bound macadam roads in similar situations, the total thickness of pavement, including wearing surface, being made the same or a little less than well constructed macadam.

After the sub-grade has been carefully prepared, spread a layer of clean stone passing a three (3) to three and one-half ( $3\frac{1}{2}$ ) inch revolving screen and held on a two (2) inch screen to a depth sufficient when thoroly rolled to form about two-thirds ( $\frac{2}{3}$ ) of the total thickness of the base. The thickness of this layer should be regulated by laying on the sub-grade at proper intervals, cubical blocks of wood of the proper dimensions to give the desired thickness. Over this layer of stone, spread with shovels stone screenings in sufficient quantity to fill the voids between the larger stone. The screenings should be spread gradually and thoroly rolled with a road roller weighing at least 10 tons during the process of spreading the screenings. As the screenings are worked into the coarse stone under the roller, more should be added here and there where voids appear. At first the rolling should be done dry until the stone appears to be well filled, then the surface should be well sprinkled and again rolled, the rolling and sprinkling continued until the layer of stone is thoroly compacted and no more screenings can be forced in. Just enough screenings shall be used to fill and bond the stone leaving no surplus screenings on the top.

The above method may be varied by using the crusher run of stone without the addition of any other filler where the small sizes are not in excess. Also a filler other than stone screenings, such as bank gravel or sand, may be used in some cases where experience with materials available shows better results can be obtained. Under some conditions the character of soil and stone available may be such as not to require the use of any filler with the stone of the first course. The specifications given, however, represent the best average practice where stone with bonding value, such as limestone or trap rock, can be obtained.

When the first layer of macadam is completed as specified, spread a second layer of clean stone passing a two (2) or two and one-half ( $2\frac{1}{2}$ ) inch screen and held on a one (1) inch screen to a depth sufficient when thoroly rolled to form the remaining one third of the total thickness of the base. Over this layer of stone spread evenly with shovels stone screenings and roll with the application of water by sprinkling. The sprinkling and rolling shall be continued until the stone is well bonded and until no more compression can be observed under the roller. Just enough filler should be used to accomplish this purpose and not enough to form a layer or film over the surface of the stone. It is better not to fill the stone quite flush, leaving the coarse particles of stone slightly projecting, so as to have a coarse, grainy base upon which to put the wearing surface.

As an alternate method of construction the macadam may be well filled with screenings, watered and rolled until flush up smooth. Over the surface of the macadam base thus constructed shall be spread a layer of clean stone of a size to pass a two (2) inch ring and be retained on a one (1) inch ring. This layer of stone shall average one and one-half ( $1\frac{1}{2}$ ) inches or practically only one stone deep and is for the purpose of forming a binder or key between the base and wearing surface and thus preventing lateral displacement of the surface. After being spread evenly it shall be lightly rolled only enough to partially imbed the stone and set them firmly in place without crushing or forcing the fine material up from below to fill the surface voids. The final rolling should be done while the macadam base is still moist and comparatively soft.

The thickness of the pavement, including base and wearing surface, should vary according to local conditions and should be fixed

by the engineer in charge when all the varying conditions of soil, drainage, traffic and materials of construction are understood. In general, a thickness of macadam base of eight (8) inches with a wearing surface of two inches will be enough for any except the most adverse conditions, and a base of four to four and one-half (4½) inches with a wearing surface of from one and one-half (1½) to two (2) inches will meet the most favorable conditions of firm, unyielding soils and light traffic.

#### *Old Macadam Foundation.*

If the pavement is to be laid on an old macadam foundation, the surface shall be thoroly swept and cleaned of all fine material that may be caked upon the surface of the stone or lying loose as dust, thereby exposing the clean, coarse stone for the reception of the bituminous concrete.

If the old macadam does not present the desired coarse, grainy surface, or is not at proper and satisfactory grade after cleaning, it shall be spiked up and redressed to the desired crown and grade, the coarse stone being brought to the top by harrowing or otherwise, or new stone added where needed. It shall then be watered and rolled until thoroly compacted. If the result is not the required coarse, grainy surface, a layer of clean stone shall be spread and lightly rolled as described above in the paragraph relating to new macadam foundation.

#### *Concrete Foundation.*

When a portland cement concrete foundation is used, it should be laid according to the standard specifications adopted for concrete foundation. The surface, however, should be roughened to form a key for the wearing surface. This may be done by using coarse stone of fairly uniform size and laying the concrete fairly wet, or by brooming, washing with a hose before hard set, tamping with grooved rammers, or by spreading a light layer of coarse, clean stone over the fresh concrete and lightly tamping.

#### *Curb.*

If a curb or curb and gutter is used, the face against which the paving material will be laid shall be painted with a coat of hot bituminous cement in advance of the pavement.

A curb or curb and gutter should be used in all cases of a street devoted to miscellaneous uses and where there is occasion for many vehicles to stop at the curb line, but in the case of a park driveway or a suburban highway, a bituminous concrete pavement may be successfully used without a curb. No other protection for the edge of the pavement is required except to provide a coarse, grainy base into which the paving material is rolled.

#### *Wearing Surface.*

On the foundation, as heretofore specified, shall be laid the bituminous concrete wearing surface, which shall consist of a mineral aggregate mixed with bituminous cement and laid as herein-after specified.

This wearing surface shall have a thickness of .. inches after thoro compression with a roller.

For heavy traffic a thickness of two (2) inches is sufficient for all practical purposes and in some cases will afford more stability than a greater thickness.

For moderate and light traffic one and one-half ( $1\frac{1}{2}$ ) inches will be sufficient thickness for the wearing surface when laid on a well constructed base as specified above.

#### *Mineral Aggregate.*

The mineral aggregate shall consist of a mixture of broken stone and sand, to which shall be added as required, stone, dust or portland cement.

Any sound, durable stone, either trap rock, limestone or granite, usually considered suitable for macadam, may be used. It should be broken as nearly cubical as practicable. It should not show distinct planes of cleavage or crystalline faces and should not readily crush or split under the roller when being rolled in the pavement. Between two kinds of stone, choice should generally be made of the one showing the greater toughness rather than hardness. A certain percentage of absorption, such as is shown by the better grades of limestone, is a desirable quality, as the bonding strength of the cement is somewhat improved thereby.

The sand shall be hard-grained, moderately sharp, free from loam or other foreign material and varying in size from that passing

a one-quarter ( $\frac{1}{4}$ ) inch screen to dust passing a two hundred-mesh screen, and there should not be over twenty per cent held on the ten-mesh screen.

Dust in the form of finely ground limestone or portland cement may be added to the mixture, but in such quantities that the screenings of the total ingredients entering into the mix shall in no case show over eleven (11) per cent by weight passing a 200-mesh screen.

The proportions of the various ingredients composing the Bituminous Concrete shall be as follows:

Passing 200 Mesh Screen,	7-10 per cent.
Passing 80 Mesh Screen, but retained on a 200,	10-20 per cent.
Passing 40 Mesh Screen, but retained on an 80,	10-25 per cent.
Passing 20 Mesh Screen, but retained on a 40,	10-25 per cent.
Passing 8 Mesh Screen, but retained on a 20,	10-20 per cent.
Passing 4 Mesh Screen, but retained on an 8,	15-20 per cent.
Passing 2 Mesh Screen, but retained on a 4,	5-10 per cent.

The minimum amount of bitumen allowed shall only be used in mixtures containing the minimum total passing the 80-mesh. The percentage of bitumen must be increased above the minimum as the total passing the 80-mesh increases.

The item designated as Dust includes in addition to the portland cement or stone dust that may be added, fine sand passing a 200-mesh screen not exceeding 5 per cent of the total mixture and such 200-mesh mineral dust self-contained in the refined asphalt.

#### *Method of Mixing.*

The aggregate shall be dried and heated in properly designated driers before mixing with the bituminous cement. The driers shall be of the revolving type, thoroly agitating and turning the materials during the process of drying. When the aggregate is thoroly dried and heated to a temperature of from 200 to 350 degrees F., depending upon the bituminous cement used, it shall be immediately before cooling or exposure to moisture, mixed with the hot bituminous cement as hereinafter specified. If stone dust is used, it shall be introduced directly into the mixer without passing thru the drier.

The bituminous cement shall be melted in a tank arranged so the heat can be properly and easily controlled and regulated. When

melted and raised to a temperature of from 200 to 350 degrees F., depending on the bituminous cement used, it shall be combined in the proper proportions with the hot aggregate and immediately mixed in a properly designed mixer with revolving blades until a thoro and intimate mixture of the ingredients has been accomplished and the particles composing the aggregate are evenly and thoroly coated with the bituminous cement. The mixer shall not be exposed directly to the action of fire.

#### *Method of Laying.*

While still hot from the mixer, the paving mixture shall be spread evenly on the foundation with hot iron rakes and shovels, so that when compressed with the roller it shall have the thickness specified, with the surface even and true to grade. Along the curb and around manholes, catch basins and other obstructions in the street, where the roller cannot reach, the compression shall be secured by the use of hot iron tampers. The rolling and tamping shall be done as quickly as possible after the material is spread, while still hot and pliable. When the paving mixture is hauled on the street in dump wagons it shall be, when ordered by the engineer, kept covered with canvas to retain heat, dumped on platforms and shoveled into place and raked to the proper grade. As soon as spread the paving mixture shall be rolled with a tandem roller weighing at least six (6) tons and the rolling continued, working lengthwise and diagonally of the street. When practicable, additional compression in the wearing surface should be secured by the use of a ten-ton roller. Rolling must be steadily kept up and continued until all roller marks shall disappear and the surface gives indications of no further compressibility.

The paving shall be done continuously, so the number of joints between the hot and cold material may be reduced to the minimum. When it is not practicable to lay it continuously and a joint is unavoidable, the edge of the cold material shall be trimmed down to a rough feather edge, and the surface, where the joint is to be made, painted over with bituminous cement, the hot material raked over the feathered edge and thoroly rolled. Instead of trimming the cold material, joint strips may be used consisting of strips of canvas about eighteen (18) inches wide with three parallel lines of three-quarter ( $\frac{3}{4}$ ) inch ropes sewed on the under side about three (3) inches apart. The joint strips shall be laid on the feather

edge of the freshly raked material with the upper rope at the line where the thickness begins to decrease and the rolling completed on top of the canvas as for finished pavement. The faces of the curb and gutter, iron castings, etc., shall be painted with bituminous cement before the paving mixture is laid.

#### *Surface Finish.*

As soon as possible after the rolling of the mixture is finished, and while the surface is still fresh and clean, and, if possible, while warm, a seal coat of bituminous cement of properly consistency to be flexible when cold shall be spread over the surface. It shall be applied while at a temperature of from 200 degrees to 350 degrees F., depending upon the bituminous cement used, and evenly spread with rubber squeegees or mops. Only a sufficient coat shall be spread to flush the surface voids without leaving an excess. Immediately over this, a top dressing of torpedo sand, fine gravel or stone chips free from dust, which must be thoroly dry and heated in cold weather, shall be spread and thoroly rolled into the surface. A small surplus shall be left to be worn in or worn away by the traffic.

In the case of park drives and roadways not subjected to heavy, constant traffic, and where a more grainy and coarse surface is desired, the surface finish specified above may be omitted and the following method of finishing adopted:

As the bituminous concrete is raked to grade, and just before the roller comes on it, spread dry stone chips or coarse torpedo sand, evenly with swinging motions of a shovel, until the surface is barely covered. Then roll thoroly as specified in the preceding paragraph relating to method of laying. If bare spots appear under the roller, sprinkle more chips or sand and continue the rolling until the whole surface is fairly covered.

After the sand or stone chips have worn into the surface the street shall be swept, all excess of surfacing material removed and the street left clean.

#### *Asphaltic Cement.*

The asphaltic cement may be prepared from the following asphalts combined with flux as hereinafter specified, if flux is necessary: (1) From refined natural asphalt; (2) from the residue

obtained in the careful distillation either with or without oxidation of asphaltic or semi-asphaltic petroleum; (3) from any uniform combination of the preceding materials together with a suitable flux, if flux be necessary, such combination being subject to the approval of the engineer.

Each bidder must state the nature and origin of the bitumen to be used by him and further, shall submit samples of the bituminous cement with his proposal.

The asphaltic cement shall pass the requirements designated below:

(1) It shall have a penetration of from 40 to 85 at 77 degrees F., depending upon the traffic and climatic conditions and hardness of the pavement desired. A penetration of from 40 to 50 in most cements will produce a hard, exceedingly stable pavement which should be used on streets subjected to constant or heavy traffic.

A penetration of from 50 to 65 in most cements will produce a pavement best calculated to meet general traffic conditions. The above penetrations are measured in hundredths centimeters with a No. 2 needle weighted with one hundred grams acting for five (5) seconds.

(2) When 50 grams of the cement are maintained at a temperature of 325 degrees F., for five hours in a tin box  $2\frac{1}{4}$  inches in diameter by  $1\frac{3}{4}$  inches deep, there must not be volatilization of more than 5 per cent by weight of the bitumen present, nor shall the original penetration be reduced thereby over one-half.

The method of test employed is that recommended by the Committee on Coal Analysis of the American Chemical Society.

(3) Of the bitumen of the asphaltic cement which is soluble in carbon disulphide,  $98\frac{1}{2}$  per cent shall be soluble in carbon tetrachloride. In this test for carbenes, the asphaltic cement to be tested should be allowed to stand over night, covered with purified carbon tetrachloride. The test to be performed in subdued light.

(4) The cement shall not flash at a less temperature than 350 degrees F., New York State Closed Oil Tester.

#### *Flux.*

Use the flux specifications prepared by the Committee on Asphalt Pavement Specifications.

### *Coal Tar Cement.*

The coal tar cement shall be residue of the distillation of coal tar only, and shall be refined for the special purpose of making a paving cement.

No mixture of hard pitch with the lighter oils of coal tar will be permitted.

Its specific gravity shall be not less than 1.20 nor more than 1.29 at 69 degrees F.

The melting point determined by the cube method shall be not less than 100 degrees F., and not more than 115 degrees F.

It shall contain not less than 15 per cent, nor more than 30 per cent of free carbon insoluble in benzol.

It shall be free from water as determined by distillation and shall show upon ignition not more than  $\frac{1}{2}$  per cent of inorganic matter.

No distillate shall be obtained lower than 338 degrees F., and up to 600 degrees not less than 5 per cent and not more than 20 per cent of distillate shall be obtained. The distillate shall be of a gravity of not less than 1.03 at 60 degrees F. The residue shall have a melting point of not more than 165 degrees F. In making this distillation an 8-ounce glass retort shall be used and the thermometer suspended so that before applying the heat the bulb of the thermometer is one-half inch above the surface of the liquid. The melting point of the pitch shall be determined by suspending a  $\frac{1}{2}$ -inch cube in a beaker of water one inch above the bottom. The temperature shall be raised 9 degrees per minute from 60 degrees F. The temperature recorded the instant the pitch touches the bottom shall be considered the melting point of the pitch. In testing the original materials the initial temperature shall be 40 degrees F.

### *Water Gas Tar Cement.*

1. The specific gravity at 25 degrees C. shall be between 1.155 and 1.170.

2. On extraction with cold carbon disulphide at room temperature for 20 minutes, not less than  $97\frac{1}{2}$  per cent shall be soluble.

3. When tested in a penetrometer at 25 degrees C. with a No. 2 needle under 100 grams load for 5 seconds, it shall have a penetration of not less than 27.5 m.m. and not more than 32.5 m.m.

4. When 100 c.m. are distill in a 250 c.c. Engler flask according to the method proposed by the American Society for Testing Materials, the loss by weight shall be within the following limits:	
From Start to 170 degrees C.....	0
170 to 225 degrees C.....	not over $\frac{1}{2}\%$
225 to 270 degrees C.....	from 2 to 6%
270 to 300 degrees C.....	from 5 to 9%
Residue.....	not less than 84%

---

SPECIFICATIONS FOR BITULITHIC PAVEMENT ON ANY APPROVED  
FORM OF FOUNDATION.

---

*Wearing Surface.*

On the foundation prepared as herein above specified, shall be laid the Bitulithic Wearing Surface and Seal Coat, described below, so as to have a thickness of two (2) inches after thoro compression. The Wearing Surface shall be composed of hard crushed stone, sand, and Bitulithic Cement.

The Bitulithic Cement herein specified besides being produced under the direction, processes, supervision and laboratory inspection of, and with ingredients approved by Warren Brothers Company, shall in all respects comply with the specifications for Asphalt Cement contained in the sheet Asphalt Specifications of the American Society of Municipal Improvements.

Either of the two following methods and apparatus shall be used in the preparation of the wearing surface.

1. The stone and sand shall be heated in a rotary dryer and while still hot separated into the desired number of different sizes by means of a rotary screen having a minimum screen opening of about  $1/10$  of an inch and a maximum opening of about  $1\frac{1}{2}$  inch. The openings in the successive screen sections up to one-half inch ( $\frac{1}{2}"$ ) size, shall not vary more than one-fourth of an inch ( $\frac{1}{4}"$ ) and not more than three quarters of an inch ( $\frac{3}{4}"$ ) for the sizes larger than one-half inch ( $\frac{1}{2}"$ ). The aggregate thus separated shall pass into a bin having sections or compartments corresponding to the screen sections. From these compartments the aggregate shall

pass into a weigh box, resting on a multi-beam scale. The desired amount of aggregates from each of the above compartments, shall be accurately weighed separately on the scale and the batch dropped into a "twin pug" mixer, where it shall be intimately associated and thoroly commingled with a predetermined quantity of Bitulithic Cement sufficient to coat all particles of the aggregate and to fill the voids in same.

2. The stone and sand shall first be carefully measured as to sizes and a definite quantity of each size shall then be fed into an elevator terminating in a hopper or bin which discharges into a rotary dryer or heater, both hopper and heater being so designed as to keep each batch by itself until heated. From the rotary heater the batch of mineral aggregate shall pass into a rotary cylindrical mixer containing blades, spirals or other devices for producing a uniform mixture of the mineral aggregate with a predetermined quantity of the Bitulithic Cement sufficient to coat all the particles of the aggregate and to fill the voids in same.

The different sized particles of stone and sand ranging in size from impalpable powder to about one-half the thickness of the wearing surface, shall be combined in such proportions as to secure in the mineral aggregate density, or low percentage of voids, and inherent stability or resistance to displacement, producing an aggregate which when combined with the Bitulithic Cement and laid in place and compacted will form a street paving structure consisting of mineral aggregate of different sizes and the Bitulithic Cement which permeates the entire mass, fills the voids and unites the various particles thereof. If the crushed stone and sand do not contain enough finely divided particles, or impalpable powder to produce a low percentage of voids in the aggregate, the deficiency shall be made up by the addition of any other suitable fine mineral matter.

The mixture and ingredients thereof shall be maintained at a temperature consistent with good workmanship. The mixture when reaching the street shall be hot enough to allow of being easily spread and raked and shall not be so hot as to injure the Bitulithic Cement.

#### *Surface Finish or Seal Coat.*

There shall be spread over the Bitulithic surface mixture a seal coat, using per square yard of Bitulithic pavement approximately one-fourth ( $\frac{1}{4}$ ) gallon of Bitulithic Cement, into which shall be

incorporated approximately twenty-five (25) pounds of mineral aggregate not larger than one-quarter ( $\frac{1}{4}$ ) inch diameter. After spreading the seal coat, it shall be thoroly rolled into the Bitulithic surface mixture. On grades a coarser aggregate may be used.

*General.*

Each layer of the work shall be kept as free as possible from dirt, so that it will unite with the succeeding layer.

The bituminous composition or cement shall in each case be free from water and shall be especially refined to remove volatile and other matter susceptible to atmospheric influences.

Warren Brothers Company, owner of the patents used in the construction of the Bitulithic Pavement, shall file with the proper official or board which is about to receive bids for the work, a properly executed binding agreement to furnish any contractor desiring to bid for the work all the necessary Bitulithic Surface material, mixed ready for use, and Bitulithic Cement, and the sand, gravel, or stone screenings for the surface finish course, in accordance with Sections, "Wearing Surface" and "Surface Finish," at a definite reasonable price per square yard. Said price shall include a license to use all of the patents required in the construction of the Bitulithic Pavement as herein specified.

The acceptance of bids by..... and the letting of a contract for the same shall be deemed by Warren Brothers Company to be an acceptance of its proposal by

..... and by the Contractor to whom such contract shall be awarded, and are all that shall be necessary to bind Warren Brothers Company to said agreement. The filing of a bid under these specifications will be construed as an acceptance of the terms of the license agreement filed by the Warren Brothers Company, at the price fixed in said agreement, which is on file with the proper official or board.

---

Boston, Mass., Nov. 27th, 1915.

Mr. Chas. C. Brown, C. E., Secretary,  
American Society of Municipal Improvements,  
Indianapolis, Indiana.

Dear Sir:—

In accordance with our verbal statement to the Sub-Committee on Bituminous Paving Specifications, the General Committee on

Paving Specifications, and subsequently on the floor of the Convention of the Society at Dayton, we hereby agree that a pavement constructed by the use of the proportions of mineral aggregate enumerated below, combined with bituminous cement, will not possess the inherent stability and density covered by the claims of and, therefore, will not infringe on our patents. The proportions referred to as adopted by the Society at the Dayton convention being as follows:

Passing 200 mesh screen 7 to 10 per cent.  
Passing 80 mesh screen 10 to 20 per cent.  
Passing 40 mesh screen 10 to 25 per cent.  
Passing 20 mesh screen 10 to 25 per cent.  
Passing 8 mesh screen 10 to 20 per cent.  
Passing 4 mesh screen 15 to 20 per cent.  
Passing 2 mesh screen 5 to 10 per cent.

Very truly yours,

—WARREN BROTHERS COMPANY,

By (Signed) Geo. C. Warren,

President.

YC 69433

TE270 342938  
A53

*amer*

UNIVERSITY OF CALIFORNIA LIBRARY

UNIVERSITY OF CALIFORNIA LIBRARY

THIS BOOK IS DUE ON THE LAST DATE  
STAMPED BELOW

FEB 9 1917

